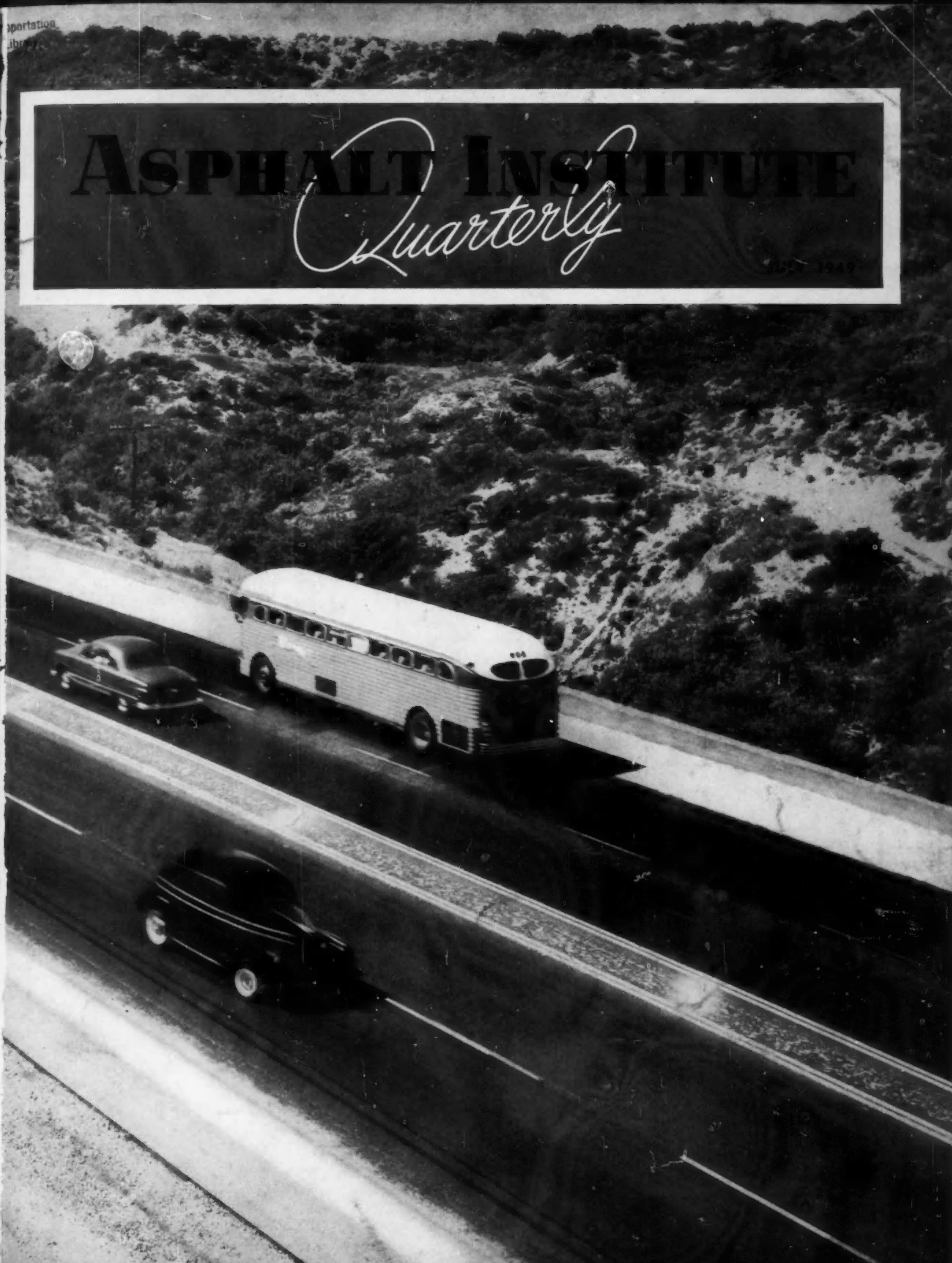
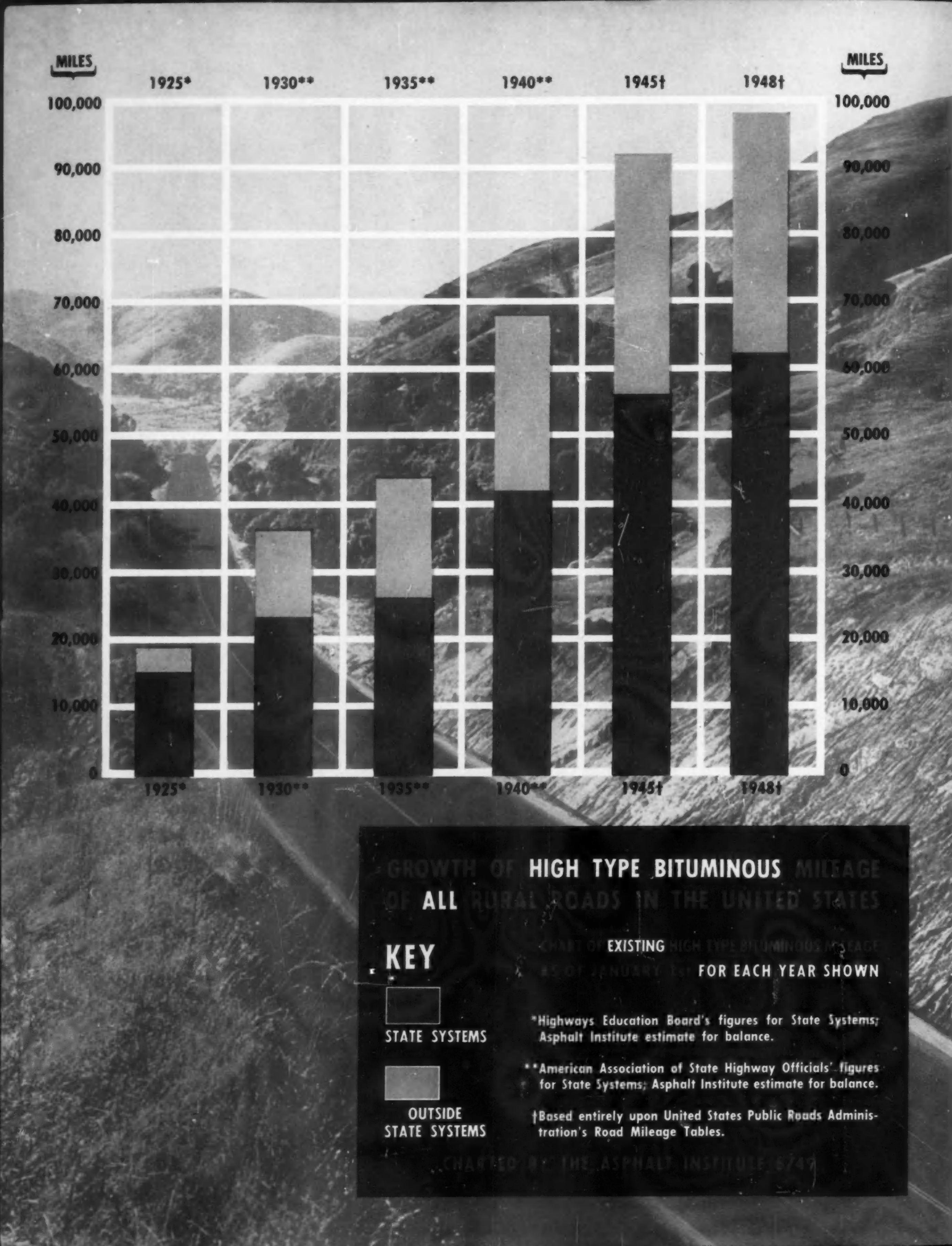
ASPHALT INSTITUTE *Quarterly*

JULY 1949




MILES
MILES
1925*
1930**
1935**
1940**
1945†
1948†
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
HIGH TYPE BITUMINOUS
ALL
KEY
EXISTING
FOR EACH YEAR SHOWN
STATE SYSTEMS
OUTSIDE STATE SYSTEMS
*Highways Education Board's figures for State Systems; Asphalt Institute estimate for balance.
**American Association of State Highway Officials' figures for State Systems; Asphalt Institute estimate for balance.
†Based entirely upon United States Public Roads Administration's Road Mileage Tables.

ASPHALT INSTITUTE Quarterly

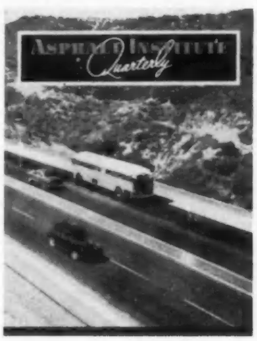
VOL. 1 No. 2 JULY, 1949

The Asphalt Institute Quarterly is published by the Asphalt Institute, a national, non-profit organization sponsored by members of the industry for the purpose of promoting interest in the use of asphaltic products.

The names of the Member Companies of the Institute, who have made possible the publication of this magazine, are listed herein on page 15.

Articles may be freely reprinted with credit line. Correspondence should be addressed to the Asphalt Institute Quarterly, 801 Second Avenue, New York 17, N. Y.

CONTENTS



COVER

Featured on the cover, is the heavy-duty, *asphaltic* concrete "Ridge Route" near Los Angeles. This great highway, the most important in Southern California, crosses the Tehachapi Mountains at 4,200 feet elevation and is the only direct highway connection between Metropolitan Los Angeles and the San Joaquin Valley.

The graphic chart featured on the opposite page illustrates the steady growth of *High Type* Bituminous mileage in the United States on state systems and all other rural roads. It does *not* include city streets, nor the approximately 350,000 miles of lower types of bituminous rural roads.

EDITORIAL

The building of highways constitutes one of our largest single engineering activities. Highways range from the smallest country lane to the busiest urban expressway. All are important and each must receive due consideration in the overall picture of transportation. It is just as necessary that the single daily can of milk be carried from the farmhouse to the first gathering station as that the tank truck reach the city bottling plant. The difficulty arises in apportioning revenues so that each link in this highway chain receives the appropriate needed improvement, no more no less. Highways are classified generally as in the *primary* or *secondary* systems. This issue of the "Quarterly" deals with *primary highways,* particularly those designed for *heavy duty,* which as a group include the state highways upon which Federal Aid is expended. Secondary roads will be discussed in a later issue.

What is a heavy-duty highway? Some define it as one which carries a preponderance of large trucks; others think in terms of large volume, including both passenger and commercial vehicles. It thus is evident that a correct concept as to the effect of the particular traffic is most important and that a great deal of money can be expended unnecessarily unless each situation is appraised most carefully. Even a traffic census may give but incomplete information. Numbers have a meaning, but only if fully analyzed. For example, adjacent to many cities there is great need for wider roads to accommodate morning and evening traffic. Such traffic, however, often is composed largely of light weight units which cause relatively little wear and tear upon a pavement, requiring only a light surface if placed upon a proper foundation.

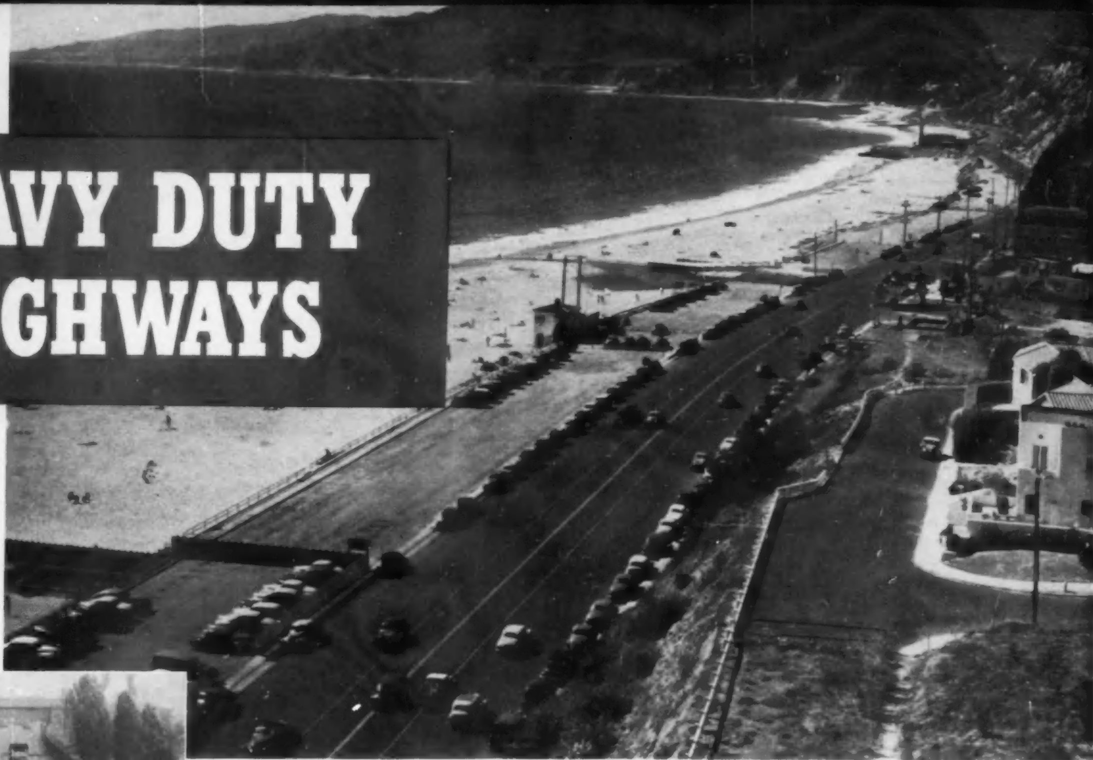
On the other hand, the definitely heavy truck arteries require substantial thickness as well as width, if traffic is to move freely and safely. The influence of temperature and moisture also has important bearing. In many locations, heavy volume traffic is seasonal, as where adjacent to resort areas. In the summer even a *six-lane* highway may be required, while for the winter a *two-lane* surface is ample. For such locations four lanes should be designed for summer traffic, with the remaining two lanes of thickness required to take care of the heaviest winter loading.

Do we design highways according to such concepts? Sometimes, but all too often we do not. Highways in many instances cost too much. As one studies the procedures followed in different sections of the country, he cannot fail to be amazed at the *variation in the existing ratios* between gas tax, bonded indebtedness, motor vehicle registration, and road mileage.

Of our entire paved highway system, including both light and heavy-duty surfaces, bituminous surfaces constitute some 450,000 miles, or over 80 per cent. In recent years *heavy-duty* bituminous pavements have shown marked increase in mileage, *as charted on the opposite page.* Two basic reasons account for this preponderant use: one is the ability to utilize foundation values to the maximum degree; the other, the ease and rapidity with which resurfacing can be accomplished, transforming old rough pavement to smooth riding high type asphalt. Typical examples of such development are shown in the following pages.

HEAVY DUTY HIGHWAYS

California's U.S. 101, north of Santa Monica. Heavy duty *asphaltic* concrete, four lanes constructed in 1932, two lanes added in 1935. 16 hour traffic count, Sundays 32,000; week days 20,000.



Courtesy "California Highways and Public Works."

Heavy-duty *asphaltic* concrete on New Jersey Route 1, — a vital link in traffic for New York, via the Holland and Lincoln Tunnels.

Heavy-duty asphaltic concrete, on Communipaw Avenue, Jersey City, carrying the heaviest concentration of traffic for the industrial centers of Jersey City, Bayonne and Port Newark, as well as via tunnels, for New York.

HIGHWAY BUILDING IS AN ART AS WELL AS A SCIENCE. As a science it is a system of measurements by which the physical forces may be evaluated, and structures then designed which will support anticipated loads and resist deterioration for long periods of time. Frequently there are several possible alternate methods of procedure based upon such science. The art of highway building, therefore, is to utilize to the best advantage local resources in such manner that pavements meet the required established standards.

There is great variation in regard to the development of this art. It sometimes happens that a type of surface is selected without regard to the local situation and materials frequently are hauled hundreds of miles unnecessarily, whereas the effort should be made to investigate the local resources to see whether they may be substituted and actually secure even better results. In recent years, many aggregates formerly considered unsuitable have been evaluated, and through skillful treatment, have been so utilized as to give adequate service, at marked reduction in cost.

THE SUBGRADE CARRIES THE LOAD

In the final analysis, the subgrade, "Mother Earth" itself, must carry the load. The pavement serves merely as a layer to take wear and to transmit the load over a larger area of subgrade so that its supporting power shall be entirely adequate.

Almost everybody knows that some subgrades support loads better than others. Sands and sandy loams naturally drain more completely and dry out faster than sticky clays, and therefore are better able to support traffic under changing weather conditions. It follows then that a pavement placed upon good soils, usually can be somewhat thinner than one placed upon inferior soils. During the past decade, these variations in behavior have been carefully measured. By making certain field and laboratory tests, it is now possible to predict how a soil will change in its ability to support loads throughout the year with changing temperature and moisture conditions.

This new addition to the science of highway building is called *soil mechanics*. It has become most important

in the determination of new highway designs, as the widespread application of the fundamental principles involved may result readily in the saving of hundreds of millions of dollars. We have heard much about permanent pavements — there is *no such thing*. However, the nearest to a permanent element in the highway as a whole can be the foundation or the subgrade itself. If it is properly prepared and adequately drained, it is practically indestructible. Then if the proper type of pavement is constructed, periodic treatment to replace traffic wear becomes a relatively simple and inexpensive procedure.

ASPHALT MEETS ALL REQUIREMENTS

It is believed that for present-day conditions, the flexible type pavement meets completely the all around requirements of low first cost, low maintenance, and total adequacy for any degree of traffic. Asphalt pavements are the principal flexible pavements, and can be constructed in thicknesses varying quite exactly in accordance with the particular needs of each situation. Thus, asphaltic types include the full range of needed surface designs from treatments of less than one inch, to *asphaltic* concrete sometimes constructed eight or nine inches in thickness. Asphalt penetration macadam and asphalt plant-mix are heavy-duty pavements and suitable for the very heaviest traffic conditions, *including highways used almost exclusively by transport trucks.*

ASPHALT PENETRATION MACADAM

Asphalt penetration macadam is constructed with quite coarse crushed aggregate and consequently is useful in areas where stone, slag and large gravel is economically available. In addition to its use as a long wearing surface, asphalt penetration macadam is used also for foundations, where great strength is provided through the interlocking of the coarse particles. Asphalt plant-mix may utilize both crushed and uncrushed aggregates, and consequently fits in with the broadest category of local conditions. With the adoption of mechanical spreaders for laying plant-mix, it has become possible to place such surfaces with the smoothest riding condition of all pavements.

ASPHALT PLANT-MIX

Asphalt plant-mix is a general term used to describe mixtures of asphalt and aggregate, combined together, in controlled proportions, in a plant especially designed for the purpose. When the aggregate is composed entirely of sand the mixture is commonly known as sheet asphalt. When coarse particles of a size greater than about one-eighth inch make up more than one-half of the aggregate, the mixture is called *asphaltic* concrete. Sheet asphalt is employed largely on city streets and has a long and satisfactory service record. Many such pavements are over thirty years old. *Asphaltic* concrete is used both on urban and rural pavements, and at present is the type most rapidly increasing in use because of the ease of manufacture and placement. One great advantage of asphalt plant-mix types, is the ability to place, by machine methods, variable depth surfaces beginning with as little as one-half inch thickness. This is a quality inherent only in flexible type surfaces and means that old pavements may be restored to perfect riding condition at minimum cost.

TESTS INSURE ADEQUATE PAVEMENT

In addition to the proper construction and necessary thickness to meet a given subgrade condition, there are two other qualities required in a satisfactory asphalt pavement, one stability, and the other density. Stability is that quality of strength, which built in to the pavement will provide complete resistance to lateral movement so that the pavement remains in as smooth condition as when constructed. The second item, density, is that degree of consolidation of the pavement as will insure a waterproof, erosion-resistant condition. Adequate test methods are well established to determine these qualities in the laboratory so that, as designed, proper service behavior will be assured. Details in this regard are presented in the article under Tests on page 6.

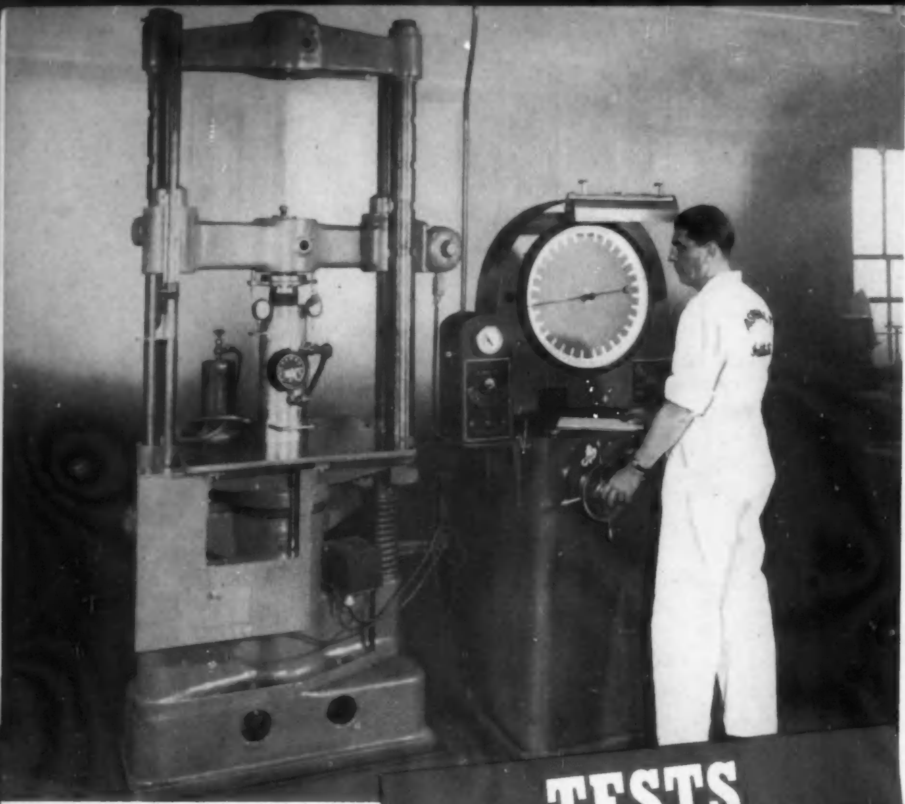
A review of current practice and appraisal of future needs thus indicates that wherever the location and whatever the conditions of traffic, appropriate selection of an asphalt pavement type will meet all requirements.

BEFORE — Rumson Road, near Seabright, New Jersey, originally constructed in 1917, twenty feet wide, with an *asphaltic* concrete wearing course 3" thick.

AFTER — the same road, widened in 1947 to thirty feet and the entire width given a 1" sheet asphalt wearing course.

BEFORE — U.S. 50 in Virginia, west of Washington, originally constructed of surface treated gravel for light traffic.

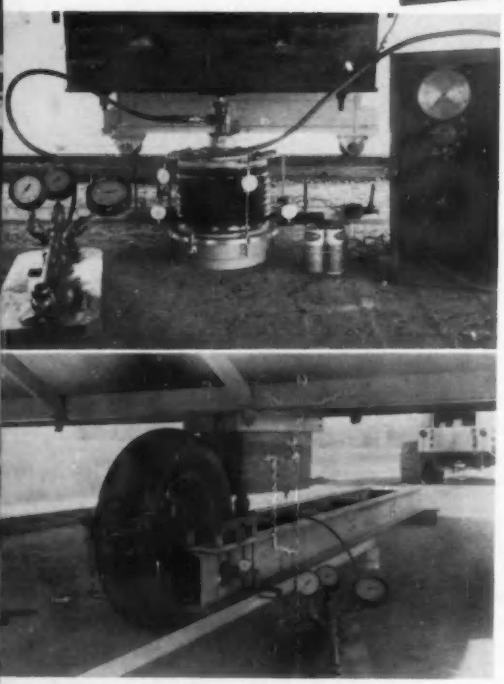
AFTER — The same four-lane gravel road, improved with *asphaltic* concrete to handle the present tremendously increased traffic that developed during the war years.



Running a Triaxial Shear test in the Asphalt Institute Laboratory to predetermine qualities of *asphaltic* concrete.

TESTS

IN THE LABORATORY AND IN THE FIELD



Load test assemblies actually measuring the finished road, using two types of bearing surface.
(Courtesy U. S. Public Roads Administration).

There are several methods of determining the required thickness of flexible type pavements, including the Asphalt Institute procedure as set forth both in the "Asphalt Handbook," and the manual on "Hot-Mix Asphaltic Concrete Paving," the CBR method, as developed by the California Division of Highways, and others. A report on nationwide state design practice, based upon actual service history, appeared in the 1939 Proceedings of the National Highway Research Board.

Later, the federal agencies, including the Public Roads Administration, the Corps of Engineers, the Navy, and the Civil Aeronautics Administration, each developed methods for design of airfields. Although airfield loads usually are in excess of those found on highways, their lightest are quite similar to the heaviest highway loads, so that excellent comparison of design and service behavior has become available from this source.

QUALITY IN ASPHALT PAVEMENT

Highest quality in the asphalt pavement is assured through proper design of the mixture, complemented by competent supervision of the manufacturing and laying processes. Testing engineers, chemists, and inspectors should be retained for this purpose.

Mineral aggregates and asphalt cements used in heavy-duty pavements usually are required to meet standards established by the American Society for Testing Materials. These standards have been adopted after years of study and are revised from time to time to meet new conditions.

PROPER PROPORTIONING

Determination of proper proportions of mineral aggregate and asphalt requires competent engineering, for which details are given in Asphalt Institute manuals and specifications. A properly proportioned mix is one that has sufficient strength and waterproofness to withstand traffic and the weather with little or no change over a long period of time. To measure these characteristics, adequate tests have been established and should always be employed.

Aggregates often are so shaped and can be so graded that one combination may have an interlocking condition which will give a high inherent stability, while another combination of aggregates may lack this essential almost entirely. In the first instance, a lower asphalt cement content may yield a mixture of satisfactory stability but, as *sufficient asphalt cement content* is to a great degree responsible not only for *durability* but also *waterproofness* of the pavement, it should not be sacrificed for this purpose.

MACHINES TO MEASURE STABILITY

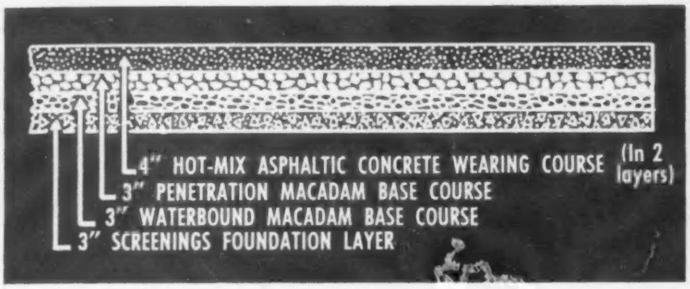
The four best-known machines used for measuring stability are:

1. Hubbard-Field (See Asphalt Institute R. S. 1 and C. S. 72)
2. Triaxial Shear (See Asphalt Institute C. S. 72)
3. Hveem Stabilometer (See December 1935, Proceedings Highway Research Board, Part II.).
4. Marshall (See December 1948, Proceedings Highway Research Board.)

Reference to the foregoing publications will provide full information as to proper procedures to be followed whereby asphalt pavements of top quality may be secured.

MARYLAND — Eastern Avenue in Baltimore County — Heavy-duty *asphaltic* concrete highway serving industrial area; traffic count 14,000 vehicles per day. See cross-section below.

MAINE TURNPIKE — Heavy-duty *asphaltic* concrete pavement, extending from Portland, Maine, to Portsmouth, New Hampshire. See cross-section below.



ALONG THE ATLANTIC

The Atlantic States represent about every possible kind of climate, aggregate, and traffic condition. On U. S. Highway No. 1 alone, including the cities of Boston, New York, Philadelphia, Baltimore, Washington, and on south, there passes daily some of the heaviest traffic in the world, serving directly over thirty million people. Westward from this great trunk line go many other important State and U. S. Highway Routes supplying the large industrial centers of North America. So it is but natural that within this area should be found outstanding examples of highway design and service history.

New Jersey in 1893, followed shortly thereafter by Massachusetts, were the first two states to establish highway departments; and drawing upon their natural resources, they developed standards for stone and gravel road construction, which in basic fundamentals continue unchanged to the present day. Incidentally, there are many miles of these roads, built in the early 1900's, which still serve traffic as foundations under the newer wearing courses today required for fast-moving, rubber-tired traffic.

USE OF LOCAL MATERIALS

It is hard to overemphasize the merit of this utilization of local resources, for it means not only the soundest kind of engineering design, but great economy as well. Well constructed stone, gravel and slag bases are practically indestructible when protected by asphalt surfaces, as the thousands of miles of such design thirty, forty, fifty years old, so well attest.

The long-wearing asphalt penetration macadam roads of the North Atlantic States make use of the fine trap rock and limestone abundant in that area, — an ideal use of *local materials* typical of the manner whereby engineering "know-how" can make the highway dollars invested produce the best returns.

THE MAINE TURNPIKE

One of the recent outstanding *asphaltic* concrete projects, the Maine Turnpike, constructed in 1947, was the largest single highway job of that year. Nearly fifty miles in length, connecting Portsmouth, New Hampshire and Portland, Maine, the design of this dual highway utilized present day knowledge of soil mechanics to the full, and led to the saving of over a million dollars as compared with competitive designs.

"STAGE CONSTRUCTION"

"Stage construction" often is the logical type of highway development, as light traffic today may be heavy traffic tomorrow. Stone and gravel roads are well adapted to such procedure, as illustrated, for example, by U. S. 50 in Virginia, shown on page 5.

NEW YORK — The Albany-Schenectady Road — 2½ inches hot-mix *asphaltic* concrete resurfacing; traffic count 10,000 vehicles per day.

PENNSYLVANIA — U. S. Route 22, Harrisburg-Easton. Rigid type pavement resurfaced with 3 inches of *asphaltic* concrete in 1948; traffic count 9,000 vehicles per day.

OHIO — U. S. 25 South of Perrysburg — Heavy-duty *asphaltic* concrete; traffic count 5,000 vehicles per day. See cross-section below.

OHIO — Cleveland Memorial Shoreway along Lake Erie. Heavy-duty *asphaltic* concrete; traffic count 60,000 vehicles per day. See cross-section below.

AROUND THE GREAT LAKES

The States immediately adjacent to the Great Lakes include the most intensely developed industrial area in the world. During the recent war their highways carried even heavier than usual traffic, as overloaded trucks pounded over them twenty-four hours a day, hauling material to make the various machines so urgently needed overseas.

TEST TRACK IN MICHIGAN

One unusual development in this heavy-duty area was the construction of several tracks over which thirty and fifty ton *tanks* were tested before shipment. For the Chrysler track at Detroit, as pictured, and where other types had failed, six inches of hot-mixed, hot-laid, *asphaltic* concrete, in four layers, upon a gravel base, provided the required stamina, and proved to be *the only roadway* capable of taking the grueling punishment given by heavy track-type armored units, whether steel-shod or rubber-shod, without eventual failure.

OHIO AND INDIANA HIGHWAYS

In the years since 1930, high-type bituminous roads on the state system increased from 300 to 4500 miles in Ohio and from 180 to 1130 miles in Indiana. This development included two kinds of improvement, one the construction of *asphaltic* concrete over newly built flexible bases; the other, the salvage of existing rigid pavements, and also gravel, stone and slag surfaces, through widening and resurfacing with asphalt.

DESIGN

Throughout this area, as elsewhere, pavement thickness is varied according to soil conditions, the important consideration being to construct the lower layers, when over poor soils, with inexpensive materials. For example, the substantial sub-base required on plastic soils may consist of granular material of many varieties. Usually this is economically available from nearby quarries, or gravel pits, and consists of bank slag, crusher-run stone, bank gravel or even coarse sand.

The cross sections of the Cleveland Memorial Shoreway and U. S. 25, as shown, are good illustrations of the range of thickness requirements for varying subgrade conditions. The eight-lane pavement on the Cleveland Memorial Shoreway, although averaging over 60,000 vehicles in 24 hours is of comparatively light design because of the naturally high supporting power of the sandy soil on which it is built. In contrast, the plastic clay soil under U. S. 25, south of Perrysburg, requires a thick sub-base, the lower portions being composed of limestone screenings from a nearby quarry.

INDIANA — Richmond, opposite Earlham University. Heavy-duty *asphaltic* concrete; traffic count 10,000 vehicles per day.

MICHIGAN — Heavy-duty *asphaltic* concrete Tank Testing track at Chrysler plant — Detroit.

COLORADO — Denver-Santa Fe Drive widened and rebuilt in 1948 with *asphaltic* concrete. See cross-section below.

ILLINOIS — Cook County. Rigid type pavement on Route 83, resurfaced and widened in 1948 with *asphaltic* concrete. See cross-section below.

IN THE MIDWEST

Chicago is the second largest city in America. As in other municipalities, most of the street surfaces are of asphalt, and Michigan Boulevard and State Street, with their fashionable shops, are well known examples of such construction. Surrounding Chicago, Cook County's great network of highways is faced with the ever pressing problem of improving old roads that have proven inadequate. In 1948, near Mount Prospect on State Route 83, an old twenty foot rigid pavement, as pictured with cross-section, was widened to forty feet and the entire road then resurfaced, using *asphaltic* concrete both for widening and new pavement. Base mixtures ranged to one inch size aggregate, with the wearing course having a top size of one-half inch, thus securing the economy inherent in flexible design.

DENVER'S SANTA FE DRIVE

One thousand miles west of Chicago is Denver, the mile-high city of the Rockies. The same difficulty of growing traffic and limited funds is present here as everywhere, and when the necessity arose of substantially improving the Santa Fe Drive south on U. S. Route 85, the decision was to use asphalt. The existing twenty year old road was thirty feet wide and consisted only of a two inch asphalt mat. The new road, as pictured with cross-section, is sixty feet wide, with a stable aggregate base and asphalt surface, which will be entirely adequate for the 10,000 vehicles that daily travel this highway.

FLEXIBLE DESIGN IN IOWA

Between these cities lies a large part of the agricultural empire of America. Iowa, where 90 per cent of the land is tillable, has an unusual problem because of the naturally full land development plus numerous cities and towns. An example of economical road improvement in this area was a project constructed in 1948 to take care of a daily traffic of about 3,500 vehicles, of which 500 are trucks. This road, pictured here, is U. S. Route 18 west of Mason City, and typical of modern design procedure. Several items are of interest, (a) the stone sub-base was compacted to 100 per cent Proctor density, (b) the *asphaltic* concrete was compacted in two inch layers, and (c) the outside edges of sub-base and base were constructed on a one to one slope, thus insuring complete stability in the finished pavement.

ILLINOIS — Sheet asphalt on Chicago's Michigan Boulevard.

IOWA — Newly constructed *asphaltic* concrete paving west of Mason City on Route 18.

SAN ANTONIO — Photographs above illustrate placing first 3" binder course of hot-mix *asphaltic* concrete on U. S. Highway 81.

The same widening and resurfacing project, showing the first 3" binder course in place. See also cross-section below.

IN THE SOUTHWEST

The great Southwest presents extremes in climate and soil conditions which require careful evaluation by the engineer. Annual rainfall varies from a minimum of nine inches in the desert areas to a maximum of fifty-eight inches in east Texas. In the arid sections, subgrade support is high and relatively thin asphalt surfaces on bases of nominal thickness have proven entirely adequate. In other areas, however, with clay soils and heavy rainfall, base construction must be heavier and wearing courses thicker and stronger. Such designs, emphasizing the adaptability of asphalt types, are to be noted in two recent expressway projects, one in San Antonio, and the other in El Paso.

TEXAS DESIGNS

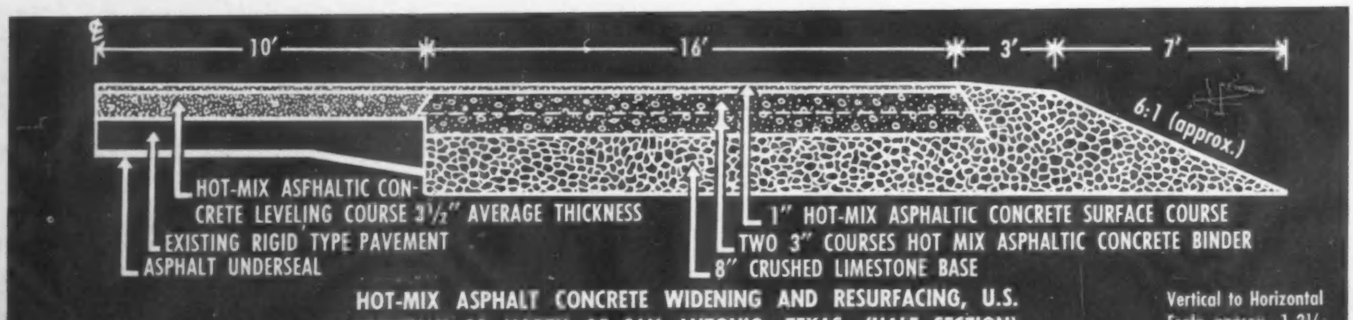
In San Antonio, as shown in detail by accompanying illustrations and cross-section, an old twenty foot rigid surface was incorporated into a new composite pavement fifty-two feet wide. For the widened portion, a sub-base course of crushed stone eight inches thick was placed, followed by six inches of hot-mixed *asphaltic* concrete. Over the old surface, a leveling course three and one-half inches thick was placed to match the widened portion. Then a one inch thick final layer of hot-mix was placed over all, achieving the final smooth-riding surface required.

In semi-arid El Paso, with higher natural soil support, a ten inch caliche (lime) base, with only a two inch *asphaltic* concrete wearing surface, provides the same load support in the final pavement as that obtained by San Antonio, and indicates the economies which may be secured through full appraisal of local conditions. A similar design is being employed on the Urban Project through Tucumcari in New Mexico.

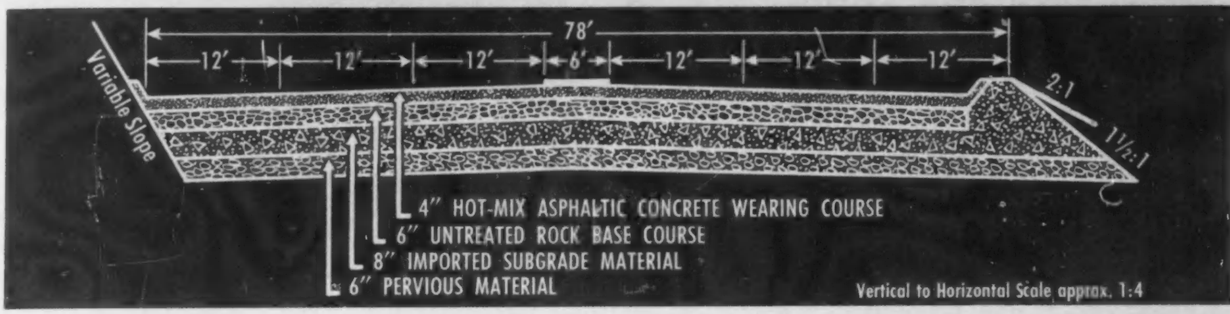
Two new contracts which will be followed with interest in 1949 are sections of Interregional Highway U. S. 67 northeast of Dallas. One has a sub-base course twelve inches thick of selected low-cost material with a seven and one-half inch *asphaltic* concrete pavement; the other uses the same type sub-base, a four inch gravel base and five and one-half inches of *asphaltic* concrete. These designs reflect the variation in composite section that may be employed to produce highway transportation service most economically.

LOW MAINTENANCE COSTS

One element of highway costs is maintenance. It is, of course, false economy to build too light a structure where maintenance costs may soon eat up the initial savings. Hence, accurate records are of great value in showing just how different pavements do perform under traffic. For twelve years, accurate costs have been kept on U. S. Route 81 between Austin and San Antonio, a distance of approximately seventy miles. There are eight different types of surface on this route, including both rigid and flexible pavements. One section, three-lanes wide, has a five inch surface of hot-mix *asphaltic* concrete, and over the years shows an average annual maintenance of pavement and shoulders of $158.00 per mile, or only $0.009 per square yard. This is the *lowest maintenance cost* of all the types reported, and reflects the durability that can be built into heavy-duty asphalt pavements.



HOT-MIX ASPHALT CONCRETE WIDENING AND RESURFACING, U.S. HIGHWAY 81 NORTH OF SAN ANTONIO, TEXAS, (HALF SECTION)



Cross section of the roadway pictured on cover, — Southern California's "Ridge Route."

PACIFIC COAST STATES

The Pacific Coast includes a *range* of climatic conditions probably greater than any area of comparable size anywhere else in the world. Mount Whitney, the highest mountain in the United States, snow covered the year around; Death Valley less than a hundred miles to the east, yet below sea level and with summer temperatures of 130° F. not uncommon; Southern California, sub-tropical and eastern Washington with its tremendous snow-falls — all provide the widest variety. Here the engineer must design to meet extremes indeed, yet here, as elsewhere, asphalt has been employed to meet the needs of both the lightest and heaviest traffic.

CALIFORNIA'S "RIDGE ROUTE"

Of perhaps more than usual interest in California's highway building to handle its freight as well as passenger-car traffic is the "Ridge Route" (U. S. 99) north of Los Angeles. This great highway (see cover illustration) crosses the Tehachapi Mountains at 4,200 feet elevation and is the direct connection between metropolitan Los Angeles and San Joaquin Valley. It is estimated that the average daily freight traffic is around 12,000 tons, carried in some 1,300 trucks, three-fourths of which are combinations of four, five and six axles. Passenger car traffic adds another 7,000 vehicles daily, so that not only is this a heavy-duty highway but a speedway as well.

The original road, built 1912-18, attracted so much traffic that further improvement was begun almost immediately thereafter. In 1932, a three-lane rigid type pavement was completed, but by 1942 this had deteriorated to such a degree that further reconstruction was required. This is *rugged* territory, for during the average winter the road may be closed a half-dozen times because of short but fierce blizzards, while summer temperatures run up to 120° F. The subgrade is largely a poor soil, and slides due to trapped water are numerous.

To overcome all these difficulties, a new heavy-duty asphaltic concrete pavement is being built, with three contracts already completed and more in preparation. Full use of local rock and granular material has been made in constructing foundations for this four-lane divided highway, which not only provide the load support needed, but also are more readily drained, thus retaining stability throughout the year.

PACIFIC NORTHWEST

Oregon has long been famous for its rock roads, and the Columbia River Highway is particularly well remembered by every traveler who has viewed the marvelous scenery along its route. Not only passenger cars use these roads; the constant flow of trucks hauling fruit, huge loads of lumber and other products of this Northwestern empire make road building in both Washington and Oregon a task covering every variety and condition.

OREGON — Asphalt Macadam on Columbia River Highway. See cross section below.
Photograph courtesy Oregon State Highway Commission.

Upper: **CALIFORNIA — *Asphaltic* concrete on U. S. 40 in Alameda County near Richmond.**
Courtesy California Highways and Public Works.

Lower: **WASHINGTON — *Asphaltic* concrete on U. S. 99, near Tacoma.**
Courtesy Washington State Highway Department.

Asphaltic concrete paving on newly-completed Talbot Highway in Quebec.

CANADA

Canada, with its vast area of 3,700,000 square miles and a population slightly under 13,000,000, has its own special kinds of highway problems. The industrial areas of Ontario and Quebec are intensively developed, and highways must carry a heavy mixed traffic of cars and trucks. In other areas, while traffic is light, there is the problem of building roadbeds which can withstand temperatures ranging from 50° F below zero to 100° F above, as well as to provide in places for deep snow and ice.

This challenge has been met effectively by using *asphalt* on over 85% of the roads that have been provided with all weather surfaces.

Lake Shore Drive, Toronto, with *asphaltic* concrete surfacing.

TALBOT HIGHWAY

Canada, in 1948, had underway the longest single highway building project in North America. This was the road extending from Quebec to Chicoutimi (Talbot Highway), of which 58 miles of the 102 miles total length were paved in the single season with hot-mix *asphaltic* concrete. Here, as elsewhere, engineers made full use of local materials in building a sound foundation, so that the asphalt surface, 3 inches thick, provides all the surface strength presently required to meet both the stress of winter and anticipated traffic, including lumber and supply trucks.

Asphaltic concrete highway, Ontario, north of Barrie.

Sheet asphalt paving in Ontario. *(Left)* Dundas Street, London. *(Right)* York Street, Hamilton.

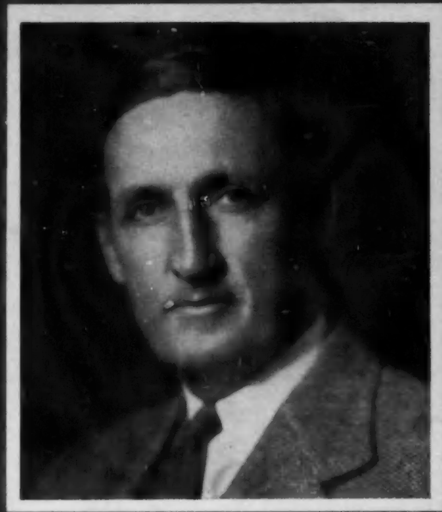
TYPICAL CONSTRUCTION PRACTICES — *A Concluding View*

In the foregoing pages there have been presented typical examples of asphalt highways carrying heavy traffic, as found throughout North America. A wholly different group of states and roads might have been selected and would have carried the same story. That story is — no road is better than its foundation; foundations may be preserved more economically with asphalt surfaces than by any other means, whether with a new road or in the salvage of the old.

PAVE AND SAVE — WITH ASPHALT.

BERNARD E. GRAY

General Manager — Chief Engineer
The Asphalt Institute



It is appropriate that a composite picture of leading magazines of the Highway Engineering Trade Press should accompany a personal photograph of Bernard Gray. Far-seeing highway engineering editors have shaped the thinking of this highway-building generation, and their pages, DURING THE PAST THIRTY YEARS have carried his many constructive contributions to their readers.

AS PUBLICIST

Bernard Gray's magazine writing constitutes one phase of his work. In it his articles have ranged from steady year-after-year exposition of sound engineering techniques in using asphalt, to his annual accurate appraisal of the economic factors affecting the over-all highway network. ADDRESSING most of the major conventions in the industry; LECTURING, — ranging from his widely-used courses on asphalt as necessary in preparation of war-time facilities, to his training talks for the future in student engineering class-rooms; PIONEERING as a leader in the establishment of a comprehensive asphalt literature, — these are other important phases of his varied publicizing activities.

AS HIGHWAY ENGINEER

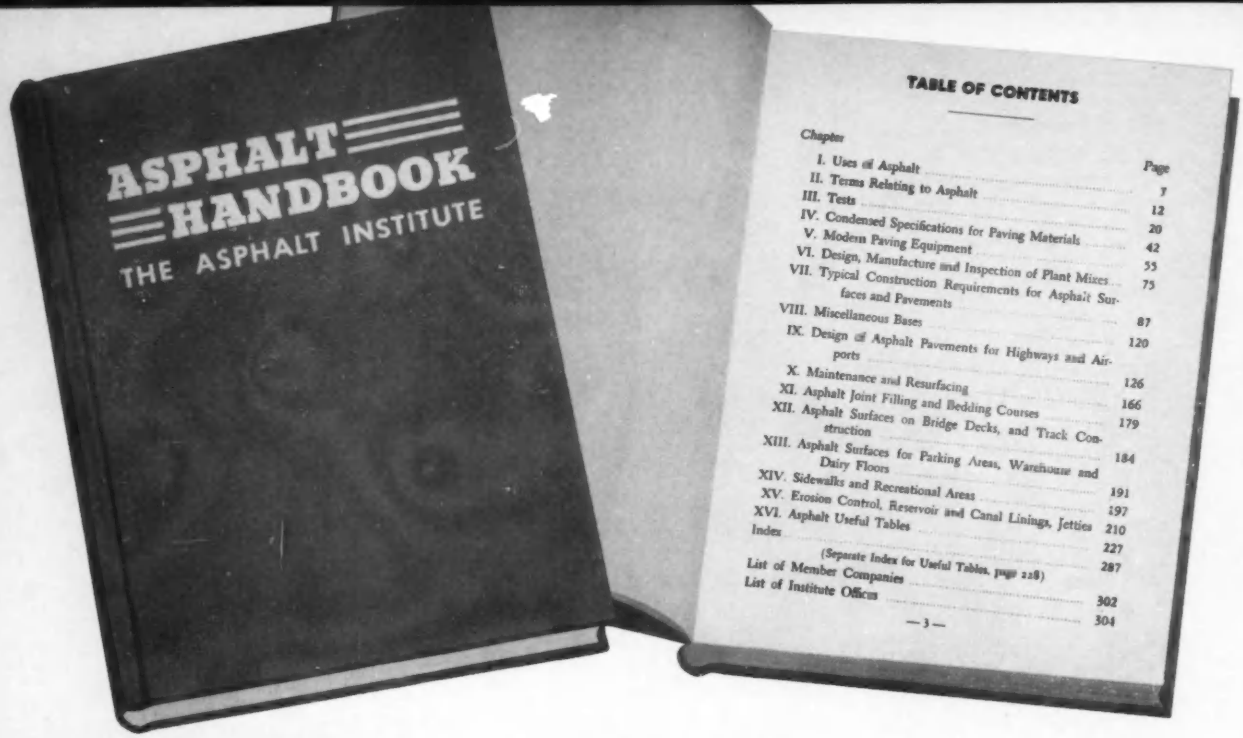
It was in 1930 that Bernard Gray came to the Asphalt Institute, but his career includes association with highway construction and maintenance for nearly forty years. Working summer vacations while still in college, his first work was with the Massachusetts Highway Commission on surveys and then after graduation as Resident Engineer. Following a year in banking he was appointed Engineer-Economist with the U. S. Bureau of Public Roads and later became Senior Highway Engineer in charge of some of the first Federal Aid Projects. During the twenties he was Division Engineer and State Maintenance Engineer in West Virginia.

AS EXECUTIVE

As General Manager of the Asphalt Institute, Bernard Gray is supervising the activities of a constantly increasing staff of District Engineers as the Institute each recent year has provided more intensive regional coverage in the promotion of the use of asphalt for road, street and airfield development. With this construction engineering field staff, he is coordinating increasing activities along research lines, in a program that thus far includes cooperation not only with the U. S. Public Roads Administration and the Highway Research Board in the Hybla Valley base and pavement testing project, but also the Institute's special studies on a national level dealing with the far-reaching potentialities of asphalt in developing the reclamation program and solving allied problems of water and erosion control.

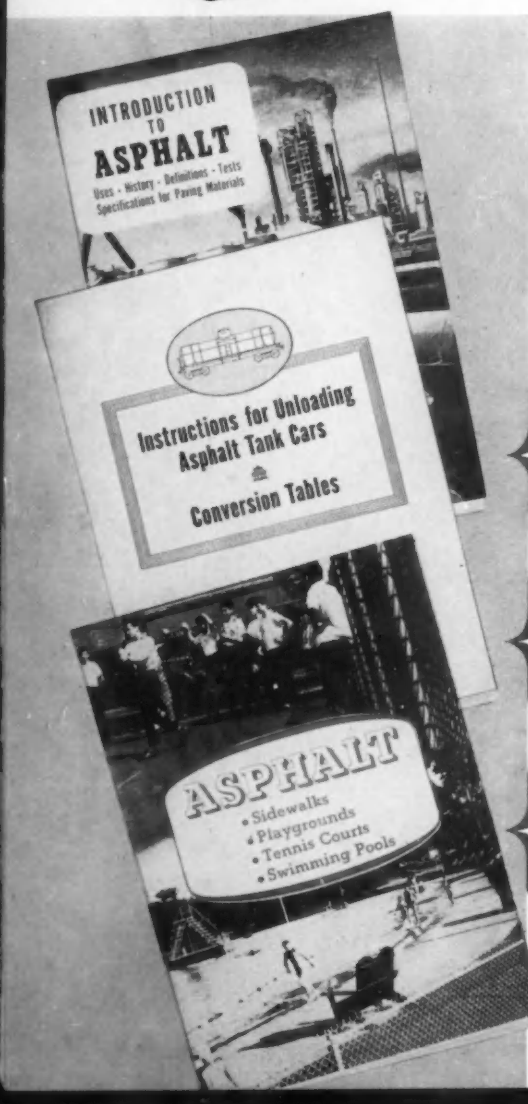
EQUIPPED FOR THE WORK AHEAD

Bernard Gray, in a planning, supervising, and coordinating role, as executive, highway engineer, and publicist, brings forty years' experience to play his part in the nation's present economic picture.



ASPHALT HANDBOOK, pictured above, known also as the "red book," is already widely used by highway engineers and public officials engaged in highway and airport work. Its recent publication is the Institute's response to a virtual *demand* by the highway building industry, that had used 100,000 copies of its slightly smaller predecessor, "Asphalt Pocket Reference for Highway Engineers." In 304 pages this newer Manual presents, in the sixteen chapters listed in the Table of Contents shown above, a condensed textbook on asphalt in its various phases—what it is, how it is tested, how it is used.

**A copy is available at the production cost of $1.00*



INTRODUCTION TO ASPHALT, is a *reprint* of the first four chapters of the Handbook, designed to make this basic information on *asphalt as a material* available at smaller cost for distribution to large groups. It is being widely used as a preliminary textbook.

**A copy is available at the production cost of 15c*

INSTRUCTIONS FOR UNLOADING ASPHALT TANK CARS, a *reprint* pamphlet containing primarily these much-used instructions, is a part of Chapter XVI—the "Useful Tables" section of the Handbook. Also included are the Weight and Volume Relations and Temperature Conversion Tables shown therein.

**A copy is available at the production cost of 10c*

ASPHALT: Sidewalks • Playgrounds • Tennis Courts • Swimming Pools is a *reprint* of Chapter XIV of the Handbook, slightly edited to make the booklet a complete entity in itself.

**A copy is available at the production cost of 10c*

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The Asphalt Institute Quarterly is presented through the courtesy of the Companies listed herewith, comprising the membership of the Asphalt Institute.

THE ASPHALT INSTITUTE
801 SECOND AVENUE • NEW YORK 17, N. Y.

PRINTED IN U.S.A.

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